UNITED STATES GEOLOGICAL SURVEY RECONNAISSANCE ENGINEERING GEOLOGY FOR SELECTION OF HIGHWAY ROUTE FROM TALKEETNA TO MCGRATH, ALASKA			· .	. 1	DESCRIPTION OF UNITS	T		Wo	·	i of one (.S. Beread of fabric to		·		אונינונ.	Value or childs or one of we	<u></u>				
By Florence R. Weber	UKIT UNIT	TITHOTOCA	TERRAIN	VEGETATION	DRAINAGE	PERMAFROST F	FROST ACTION SLO	ARING STRENGTH and OPE STABILITY	EXCAVATION  and COMPACTION	EVALUATICY FOR BOAD CONSTRUCTION and WAINTH'ANCE	UNIT	LITHOLOGY	TERRAIN	VEGETATION	DRAINAGE	PERMAFROST	. to FROST ACTION	BEARING STRENGTH and SLOPE STABILITY	EXCAVATION and	EVALUATION FOR ROAD CONSTRUCTION and 'AINTENANCE
In view of widespread interest in extending the highway system of Alaska, the Bureau of Public Roads requested the U.S. Geological Survey to prepare a reconnaissance engineering photogeologic report of an area through which a highway might be located between Talkeetna and McGrath. This report is designed to provide a general basis for determination of road routes and is concerned only with the geological factors as they would affect construction. Once a route has been chosen, detailed geologic and engineering studies in the field must be made.  The general area studied includes broad parts of the lower Susitna River valley, a smaller band through the Alaska Range, and a wide belt on the northwestern side of the mountains. At the eastern end of the area two possible sections were considered, one extending west from Talkeetna and the other west from the vicinity of Flat Lake. The route west from Talkeetna could make use of the old Peters-ville Road and then extend southwest along the mountain	Flood plain alluvium gradeu, gene Sandy layers occur as les Some bouldes Susitna dra coarse, beck tains. Kusk Gravel and tain and bri	resulty coarse deposits.  The susually cover gravel or enses within the gravel.  The sin glaciated areas.  The sin glaciat	mels of major rivers and tributary streams, maximum of five feet of relief. Susitna drainage area- Small streams flow in narrow channels in the mountains. Larger braided streams in steep-walled valleys in the mountains opening to wider channels between terraces in the lowland. Kuskokwim drainage area-Major braided rivers flow in the lowland.	mountain areas. Kuskokwim drainage areaLarge white spruce and deciduous forest or willow and alder thickets up to 30 feet high on meander flood plain. Mountain areas and piedmont same as moun-	Excellent, except for a few ox-bow lakes on meander flood-plain in the Kuskokwim drainage.	areaAbsent. un Kuskokwim drainage si	nsusceptible; when grave ilt moderate to grave ed, high well poor may	frozen. Sand and potential that the silt moderate to when thawed and middrained, low when an	ower equipment except nen frozen. Silt dif- icult to compact but ixture of silt, sand, and gravel easy to compact.	Good for foundation but subject to flooding river cutting in the spring and summer and ficing in the vinter. On meander flood plain where river confined between terraces, road construction limited to short stretches becof river channels except by long bridges or tremendous cut and fill. On the north side the Alaska Range winter winds, sometimes of hurricane velocities, blow down the large river valleys, possibly hampering snow clea ance. Abundant source of gravel for subgrad and base course, and if screened, for road metal.	12 12 13 13 14 15 15 15 15 15 15 15 15 15 15 15 15 15	silt (losss) over the morainal mater (12b)same as (12)above but with a coup to 5 feet thick of bedded gravel sand.  h silt.	rying moraine made up of long arcuate ridges with knob and kettle topography. Ridges rather sharp; local relief varies from 25 to 100 feet. A few large glacial boulders project above surface. (12a)same as (12) above, but moraines slightly older and mor	considerably with elevation.  Woraines close to the mountains a covered with heaths, dwarf birch (2-3 ft high), cottongrass tussoc and mosses. Clumps of small black or white spruce and dense thicket of alder and willow are found in protected hollows. On moraines at lower elevations, and on poorly drained slopes black spruce (about 25 ft high) and willow, alder, and heath brush are common, but in better drained areas a heavy stand of white spruce (50-60 ft high), occasional birches with an understory of dwarf birches and heath are present. Hilltops may be covered with aspen and swales with	the ridge slopes, but pool in the local kettles and in small thaw lakes forme on the old loess-covered moraines.	present in mo- cd raines near mountains. (12), (12a),(12b)  Kuskokwim drain age area-depth to permafrost 3	susceptible. (12a)Intense in silt mantle. (12b)Moderate to unsusceptible. Less susceptible where coarse material is present. silt the slowhere drawers well silt the slowhere drawers silt slowhere drawers	rempth when frozen. 2),(12b)Sand,gravel 3 boulders high when ca	ill flow into ex- avations when thawed. So bth silty and sandy ill easy to compact.	12)Ridges and knolls generally have thin over of peat, are well-drained, and offer air to good foundations; depressions have thicker peat cover and are soft and wet.  I knob and kettle areas considerable grading ecessary. Snow persists in hollows in spring.  12a)Fair to poor for road foundation where lit mantle thick-poor drainage, intense frost eaving and subject to subsidence con thawing of permafrost. (12b)Good for road construction where well drained.
front to Rainy Pass. Talkeetna will soon be accessible on the major highway system of Alaska and this route would help reopen the Cache Creek and Yentna mining districts. The other route, the east end of which is already accessible from Anchorage, would more or less parallel the old Iditarod Tail from the village of Susitna up the Yentna and Skwentna Rivers to Rainy Pass. The latter route is 50 miles shorter between Wasilla and Rainy Pass than the Talkeetna-'etersville route.  The entire area was examined by means of aerial photographs, and field checks were made by F. R. Weber and T. L. Pewe in the Susitna region in the fall of 1959 and by Weber in the summer of 1960. In the Susitna drainage area, interpretation of the bedrock is based on published reports by Brooks (1911), Capps (1913, 1935, and 1940) and Mertie (1919); study of the surficial deposits was by a detailed photogeologic study supplemented by field checks. The geology of the Farewell-McGrath area is based largely on published and unpublished works of Arthur T. Fernald (1960).	[2a] Flood plain alluvium, with thick silt cover (2b) Flood plain alluvium, low terrace with thick silt  Cover but n largely silt drainage ar sand and si Gravel lens	ilty peat. Susitna drainage gravel beds similar to unit (1) live flood plain but usually th 2 to 10 feet of fine gray lit. (2b)near Talkeetna is gravel and sand with a silt near village of Susitna is lit and silty peat. Kuskokwim rea(2a)gray, brown or mottled lit, with dark organic debris. see locally, particularly near terops and generally more	floodplains of large rivers. Level or gently sloping surface, no more than 10 feet of relief, numerous swamps and lakes in some areas. Bordered in places by a terrace scarp. (2b) represents an earlier floodplain phase and stands as a distinct terrace or series of flat terraces 10-40 feet above (2a).		(2a) and (2b) fair in the vicinity of Talkeetna, very poor near the villag of Susitna where small lakes and swamps are present. (2b) poor, very wet near Susitna and grades into bog unit (6). Only dry portions are at	areaabsent.  Kuskokwim drainage e areadepth to  permafrost 18-24 inches in forest and 12-18 inches in open, more than 10 feet under lake basins. Large ground ice masses present in organ- ic silt. Many bogs presently expanding by thaw-	stresind and gravel sinsusceptible. sand thaw drain when Slop 2/3:	ength when frozen.  t moderate to a and gravel and high when wed and well	ower equipment except hen frozen. Silt ifficult to compact ut mixture of silt, and, and gravel easy o compact.	Susitna drainage area—Good for road constriction where well drained but had where poorly drained. (2a) subject to occasional floods. The town and airports at Talkeetna, long se tions of the railroad, and parts of the new Anchorage-Fairbanks road alignment west of Talkeetna are on unit (2a). Well sorted gra accessible under silt cover in most places. (2b) is above river flooding level. Near Susitna village it is very poorly drained; for road alignment and foundation. Kuskokwidrainage area-Poor for road construction because alignment restricted by numerous swand bors. Much filling required of areas who could not be by-passed. Ground is susceptible to intense frost action and to subsidence because of thaxing of ice lenses. Gravel on sparsely available. Subject to occasional flooding.	el 13 e 13 e 13 e 13	(13)Deposit of unsorted, unstratifie boulders, pebbles, sand, silt, and a amount of clay, up to 250 feet thick Locally boulders exposed on surface exceed five feet in diameter. Compon may vary greatly in composition depeing on ht thologies present in source areasgranitic rocks, volcanic rock argillite, chert, limestone, quartz, quartzite, graywacke, slategeneral the most resistant rocks persist. Max small boulders and pebbles are well rounded. Till is gray and covered in most places with 2 to 5 feet of red-	the Susitna River lowland and shows a striking pattern of ridges elongate in the direction (largely north-south) of the movement of the great glaciers (which once filled the valley). These ridges have a relief of 50 to 200 feet and may have a core of poorly consolidated bedrock. Intervening swales hold small lakes or string bogs, or are occupied by (13a). Areas of (13a) usually have a more subductions.	story. Devil's club present. Willows, alders, heaths and stunted black spruce rim bogs. Bogs contain heaths, sedges, grasses, and water plants. (13a) Is sparsely wooded with small black spruce, larch, dwarf birch, and numerous bog plants except on the highest ridges which have same coved as (13) ridges. At higher altitude	er unit (6) but are too	present in Kuskokwim drainage area and at high elevations in Susitna drainage.Probably present sporadically at low elevations in Susitna drainage.	negligible in coarser sed- iments and sar moderate to intense in boggy silty sediments.  is In per hay street in the coarser sed- iments and sar moderate to denote the coarser sed- intense in the coarser sediments.	aring strength when ozen. In all units and, rravel, and boulers high when thawed, because in the mounins where material subject to creep. all units silty,	ccavate with power quipment when thawed it equipment will regions in poorly rained areas. Sedenents with large rade-size range asy to compact. Ilt and peat difficult to compact.	and align—and to top of, and in direction of, ridges.  Bry poor between ridges. Present Petersville and in Susitna valley crosses normal to (13) and areas and is unsuitable for heavy raffic. (13a)Good for road construction on adges but most of the unit is rather low and sampy, providing a poor foundation. Gravel is railable for base course, and, if screened, for road metal in most of the ridges of both (13) and (13a). (13b-e) In open valleys in countains this unit affords a good foundation and furnishes abundant suitable materials for
Botanical observations in the Susitna drainage area are those of F. R. Weber and in the Kuskokwim drainage area those of published and unpublished material of William H. Drury, Jr., (1956) botanist with the U.S. Geological Survey. The geologic units throughout the area were delineated by F. R. Weber. Because these contacts were determined primarily from aerial photographs they are, of necessity, only approximately located.  The Fairbanks laboratory of the U.S. Bureau of Public Roads, under the direction of Simon M. Soboleff, made the analyses of the samples collected by F. R. Weber. The Soils Division, U.S. Dept. of Agriculture, made the analyses of samples collected by A. T. Fernald in the Farewell-McGrath area.  The geologic units were first delineated on aerial	silt coveri and sand. O at the surf from 0-15 f	ified brown and gray sand and ing well-graded fluvial gravel Often a dark peat silty layer face. Thickness of silt varies ft, thinner near the mountains ces of the fans.	glacial material.	Fans near mountains covered with willow and alder brush 4 to 12 ft high, or in more poorly drained areas with dwarf birch, heath, and sedges. Farther downstream, in both the Susitna and Kuskokwim drainage areas, fans are covered with a heavy growth of spruce; white spruce with some deciduous trees where well drained and a thinner stand of black spruce in poorly drained areas.		area—absent, or present locally.  Kuskokwim drainage area—a	gravel unsus- ceptible; silt moder- ate to intense.  stre mode that drai	ength when frozen. p d and gravel high n thawed, silt erate to high when	nower equipment except then frozen. Silt dif- cicult to compact but mixture of silt, sand, and gravel easy to	Suitability for construction varies directle with thickness of silt and and cover. In general, rather good for construction in the upper parts of the fans where gravel is closurface and poor in lower garts where stis thick and ground-ice is present. Gravel available under silt in most places.	(13a) Ground more modified by outwash.	diated.  as (13) above except that (13a) is covered with well stratified deposition of boulders, gravel, and sand. Sedim generally very well rounded and less than a foot in diameter. Surficial blanket of reddish clay, silt, and sides as well as thick peat beds may be present in depressions. (13b-e)Five to 50 feet thick veneer of ground moraine overlying various types of bedrock. Locally this veneer includes locally this veneer includes locally this veneer includes locally this till may be larger and more angular than (13) and may be made up	the debouchure of old glacial channels, or in the vicinity of end moraines. Numerous lakes and bogs are present in the low area (13b-e)Blankets gently to steep sloping ground on the sides of the major valleys or on the stee sides of narrow mountain valleys (13f)Lies on moderate to steep bedrock slopes and is cut by deep (30 to 150 ft) gorges formed by old side glacial streams.	heath brush cover, with lichens an mosses. (13b-e) at low elevation has a vegetation similar to (13) as. ridgetop vegetation where trees are smaller and scattered. Steep slopes and high ridges are covered with a carpet of lichens and mosses. In protected hollows and near tree line, thickets of heath, dwarf birch, alders and willows are found. (13f) has a similar	scale. Many of the lakes are "finger" lakes, elongate in the direction of the morainal ridges. (13) is better drained than (13a). (13b-f) is well drained. Present streams tend to follow the old glacial side channels in (13f).				t b s n	pad construction. In narrow valleys and on the sides of rock domes very steep slopes may be present which are subject to landslides in ammer and avalanches in winter. Winter winds may make snow clearance difficult. (13f) milar to (13b-e) but cut by deep steep-sided mayons which would impair alignment and equire extensive bridge building.
photographs and then transferred to topographic maps. The surficial and bedrock deposits have been broken down into units, not necessarily of conventional geological formations, but into units that would be of concern to the road construction engineer. They are arranged in numerical order, roughly in relation to age—the youngest (most recently deposited) is number 1, the oldest is number 18. The geologic characteristics of each unit are described in the accompanying charts, and mechanical sieve analyses of selected samples collected in the field are shown on the cumulative—curve graphs.	lying a mix and sand. G	xture of organic rich silt Gravel may be present at		Some open black spruce forest grading down into quaking bog interspersed with small islands supporting scattered stunted spruce, larch, and birch. Sedges, peat moss, and low brush common.	Excessively poor. This is lowest-lying unit of the Kuskokum area except along the streams themselves.	Depth to perma- frost in forested areas 12 inches, just below thick moss carpet. Perma- frost, if present beneath bogs, is at depth of 6 feet or more.	str exc that jec	rength when frozen, essively low when wed. Slopes subtto land-sliding sloughing when wed.	excavate unless thaw-	Road construction almost prohibited by extremely soft, saturated ground. Difficult to stabilize soils. Almost impassable to man and vehicles except by "swamp buggy". Subject to floods by rivers and minor streams in the spring.	(13e) Ground more covering verocks. (13f) Ground more channeled.	solidated bedded rocks. (13c)Overlies well consolidated bedded rocks. (13d)Overlies granitic rocks. (13e)Overlie volcanic rocks. (13f)Is similar to (13b-e) but varies from 5 to 20 ft thand is deeply cut by channels, the bottom of which contain coarse boulde gravel, and sand.	s ick rs,				·			
The region between Talkeetna and McGrath includes some rugged terrain. The Alaska Range, with peaks averaging 6,000 feet in height, crosses the area from northeast to southwest. Elevations vary from less than 100 feet above sea level at the village of Susitna to 20,300 feet on Mt. McKinley which stands just to the north and sustains two large glaciers in this area, the Yentna and the Kahiltna, which dump large amounts of meltwater and sediment in braided streams. All runoff on the southeastern side of the range flows eventually into the Susitna River, a major north-south stream which occupies a broad, open valley. In addition to the Yentna and the Kahiltna, the Chulitna, Tokichitna, West Fork, Nakochna, Happy, and Croto (Deshka) Rivers are important segments of the Susitna drainage from the west.	covering li sand. Some	ighter colored silt and of the silt may be loess. hin layers of eolian sand	(mapped only in the Kuskokwim region), which lies slightly higher in elevation than alluvial apron unit (4).	Open black spruce forest with trees 30-35 feet high, isolated birch, and groves of aspen on high ground. Heath, dwarf birch, or willow and alder thickets extensive in swales. Bogs with sedges and heath.	Poorly integrated drainage, shallow channels choked with vegetation, numerous bogs, ponds, and thaw lakes.	Depth to perma- frost 12-18 inches. Large ground-ice masses present.	str or or dra jec lan tha mhe sta l:1	y. 00 [ -	when frozen, sloughs when wet or thawed.	Very poor for road foundation. Intense from heaving, subsidence of ground upon thawing of permafrost. Disturbance of vegetation results in thiwing and formation of a quagmire.	Silt and collu covering well	luvium overlying limestone, graywack and shale. Silt, sand, rubble, and o material with gravel locally. Propor amount and depth of collumn varies	rganic hills in the Kuskokwim drain- zion, age; local relief from 100 to ridely 1,000 feet.	about 35 feet tall, rarely white spruce, single birch trees. Willow and alder scattered or in thickets. Floor a dense carpet of mosses 8 to 24 inches thick.	Fair to poor. Forest floor is covered with a sheet of flowing water in spring; moss remains saturated throughout most of summer.  PTION OF UNITS - continued	depth to perma-	grained, poorly who drained material. who substitute the draw of t	poject to sloughing point in the point in th	sen frozen. Can be sicavated by heavy wer equipment when awed. Some blasting bedrock may be seessary.	sundation susceptible to frost action in alty, poorly drained areas. Foundation good are bedrock close to surface. Moderate rades and some sharp curves necessary to stain ridge summits where foundation is set, much sidehill cut and fill. Roads on all slopes subject to slides. Small draws and creek bottoms generally boggy and restrict on struction.
The Talkeetna Mountains form the eastern border of the Susitna valley which itself is interrupted by hills and low mountains. Talkeetna, on the Alaska Railroad (population about 150), is the largest community in the Susitna River area. Susitna at the mouth of the Yentna, once an important trading center, now supports only a very small native population. Skwentna, a Federal Aviation Agency station at the mouth of the Skwentna River, has recently been placed under remote control from Anchorage. A few mining camps on Cache Creek and on tributaries of Lake Creek as well as tourist resorts at Chelatna Lake and Puntilla Lake are operated primarily during the summer.	Bog deposits  Five to 50 rich silt a			Water plants, sedges, grasses, and low heath. In places the strings are dry enough to support stunted black spruce.	Poorly integrated drainage with a few small streams. The length of vegetation strings are generally oriented normal to local drainage.  PTION OF UNITS - continued	Sporadic ground- ice masses may be present in the drier bogs.	Intense Ver	, c	when thawed if suit- able boat or raft	Practically impassable to man in summer except when the summer and	<u> </u>	LITHOLOGY  Loosely cemented conglomerate, sandst clay shale, and lignite. Conglomerate composed of vell-rounded pebbles of v resistant rock types; generally four inches in diameter or less. Conglomer layers usually near top of the poorly consolidated rock section, occur near mountains, and are frequently a reddi	deposits throughout most of the Susitna lowland, but crops out only along deep stream cuts. Forms low benches or gentle slopes away from the harder bedrock hills. Has a distinctive	land. Near the mountains, covered with dense alder and willow thickets with a few small spruce and dwarf birch.	DRAINAGE Very good.	PERMAFROST  Locally frozen but no ground- ice masses present.	to FROST ACTION  Slight. Co be fr Sa sh fr	aring strength when ozen or thawed.  Indistone and clay alle are high when ozen, lower when are seved. Because of	hen frozen. Easy to xcavate with power quipment when thawed. ixture of clay, sand,	EVALUATION FOR ROAD CONSTRUCTION  and  MAINTENANCE  Donglomerate and sandstone good for road coundation except close to steep slopes where any gullies may be present. If screened if fines, good source for road metal. Clay akes sticky surface when wet and powdery then dry.
The Alaska Railroad passes along the eastern edge of the area and a new highway, roughly paralleling the railroad, is under construction between Willow and Talkeetna. Eventually it is planned that this road will be completed through to Fairbanks. A secondary road extends west from Talkeetna about 10 miles to the Cache Creek gold placer mines, via Petersville. Trapping, game hunting and fishing, mining, railroad maintenance, and mountain climbing are the major activities of the district. Farming, which has been carried on to a small extent for a number of years, received considerable attention recently with the arrival of the "59ers". A few of them have established homesteads on the Petersville Road.	7 fragments rate boulders. The fragments value cone, rock glacier, or local granite, vol	ranging in size from clay to the composition of the rock raries widely depending on the from which it was derived—lcanic rock, argillite, slates,	gradational with each other. Talus cones are a heap of coarse waste found at the foot of steep or nearly vertical slopes or bedrock		DRAINAGE  Very good, generally with steep gradient.	Generally absent in the coarse sediments. Occurs	TO FROST ACTION  Unsusceptible in coarse material, intense in fines.  Ear.  Ta.  Rose	frozen. Conditions Wollows when thawed: ming strength lus cone low ock glacier moderate	ated with power equip- ent except when frozen Talus difficult to compact when fines are absent	EVALUATION FOR ROAD CONSTRUCTION AND VAINTENANCE  Individually these units are of small later extent, but may coalesce. Steep overhead slopes are subject to landslides in summer avalanches in the winter, and to torrential streams in spring breakup. Generally, the units are smaller than can be shown on the		color because of iron staining or oxi Sandstone clay shale, and lignitic co make up major part of section. Sandst common in Susitna lowland, is yellowi gray, well sorted, fine to medium gra grains are subangular. Clay shale is and light gray. Coal is soft brownish black, and occurs in beds or is recog nizable as fossil tree stumps.  Graywacke, sandstone, grit, quartzite conglomerate, shale, slate, argillite	streams.  one,  in direct;  oft  Highest hilltops and mountain	Barren in high mountains or	Excellent.		un gu ma sl in we in un Frost riving Hi	fit is subject to allying. Initially y stand in steep opes but as cementing material is takened by weathering, slopes become ustable.	icult to compact.	oad foundation very good but alignment very
The land northwest of the Alaska Range is drained by the Kuskokwim River. Major streams flowing down the piedmont slope and glacial fans are the South, Middle, Windy and Pitka Forks of the Kuskokwim River, Big River and the Katlitna River. Parts of most of these streams receive meltwater from present-day glaciers so the upper reaches are braided whereas the lower sections on the silt- and sand-covered flood plain meander considerably. The Kuskokwim River itself in this area is a meandering stream and has a typical interior Alaska history of flood-plain development (Pewe, 1948; Drury, 1956).  The northwest mountain front in the area is quite abrupt, marked by a prominent fault. The South Fork of the	deposits. limestone, a material or	and even reworked glacial recent alluvium. In local ns components may be rounded ied.	may be concentrated at the mouth of small gulleys. Rock glaciers are tongue-like bodies of angular rock fragments, resembling a small glacier, occurring at high altitude in rugged terrain. Local' alluvial fans are composed of angular and rounded rock fragments of various sizes found at the mouth of large gulleys or small tributary streams. Formed by intermittent streams primarily in spring runoff or in torrential season storms.				Slope Tai	luvial fan moderate to high e stability lus cone unstable due to delicate equilibrium of de- posit. Subject to rapid movement. ek glacier good in inactive; poor to fair in active due to creep of deposit luvial fan good in flatlying, poor in sloping deposits;	compact. Alluvial fan easy to compact if variety of size grades pre-	1:250,000 scale maps. The presence of these units in the narrow Rainy Pass valley and at the Hell's Gate on the South Fork of the Kuskokviz River is to be noted when evaluation of a road route through the mountains is made. Good source for base course but some crushing may be necessary.	Well consolida bedded roc	limestone, tuff etc. Covered in many places by till, colluvium, and loess than five feet thick.	highest hills and lower mountains have been glaciated and present rounded knobby surfaces. Highest mountain areas are extremely rugged with steep-sided or nearly vertical valley walls, with matternorms, aretes, cols and other features, the result of the sculpture of glacial ice. Active glaciers are present. In the Kuskokwim drainage the highest hills may be rounded or pinnacled summits.	with carpet of lichens and mosses. Heaths and dwarf birch, with alder and willow thickets in protected gullies near treeline. At lower elevation an open forest of white spruce (up to 60 feet high) or dense groves of aspen or birch.		but no ground- ice masses present.	common. st	ir pi pi Di ir	ng, particularly on innacled ridge crests, cobably necessary.	ifficult in high mountain areas because of accessively steep slopes and rugged terrain. Sood for riprap, base course, subgrade or servious fill. Good for road metal and aggregate if crushed and screened.
Kuskokwim River arises deep in the mountains. Rainy Pass, a low-altitude (3,000-4,000 ft), winding, narrow, steep-sided pass lies at the drainage divide between the South Fork and the Happy River in the Susitna drainage. Another low (2,000-3,000 ft), generally broad pass (Houston Pass) lies in upper Ptarmigan Valley between the headwaters of the Happy River and of the South Fork of the Kuskokwim River. Along the latter route is one narrow canyon 4 miles long on the South Fork at Hell's Gate. Shorter, high-altitude passes (4,000 ft. plus) are also present between the Susitna and Kuskokwim drainage.  The major population, trading, and transportation center of the northwestern part of the area is McGrath (elevation 349 ft) on the Kuskokwim River with approximately 250 persons.	8 up to 75 fee zone at top.	orly graded tan-gray sand et thick with thin reddish b. Locally covered with one- dark organic silty layer.	Dune-covered plain, character- ized by long dune ridges and irregularly shaped dune areas. Ridges about 3/4 mile long, gently curved, maximum relief of about 50 feet. Generally aligned NE-SW with concave side to south- east. Slope on southeast averages about 20 percent; on northwest side from 30 to 40 percent. Interdune portions relatively level, with	areas have open black spruce	Mostly well drained with local swampy areas. Sand very permeable.	shallow depths except very v	Unsusceptible except intense very locally in	subject to land- slide.  h bearing strength n frozen or thawed. rozen sand slopes		Fairly reed for road foundation. Minimum grades on roads aligned parallel to dune ridges (NE-SK). Local boggy areas can be avoided. High escarpment near Kuskokwim River limits approach from that direction.	Granitic rock	Granitic or intrusive igneous rocks such as granite, monzonite, granodiorite, diorite, or diabase. Covered in a few places by till and colluvium less than five feet thick.	Forms some of the highest and most rugged peaks of the mapped area in the Alaska Range where active glaciers are present; also forms Mt. Susitna and a few low-lying rounded hills in the Susitna drainage.	Barren in high mountains or	Excellent.	Locally frozen but no ground-ice masses present.	except by ver	ry steep stable   he quin   he ppes.   le quin   he	avy equipment for arrying and crush- g. Frost-rived cocks on surface sy to excavate.	and foundation very good but alignment ary difficult in high mountains because of accessively steep slopes and rugged terrain. I limited areal extent at lower elevations. and for riprap, base course, subgrade or provious fill. Good for road metal and agregate if crushed and screened.
Farewell (elevation 1538 ft), at the mountain front near the South Fork, is a Federal Aviation Agency communications station. A few small native summer camps are found on the Kuskokwim River. The primary transportation in the area is by boat and by air in summer or by dog team and by air in winter. The only road is from Sterling Landing on the Kuskokwim 18 miles downstream from McGrath to the gold mining centers of Takotna and Ophir, 43 miles northwest.  Climate  Climatically the region of this study comes within the classification of "Subarctic" with mean annual temperatures	9 a 9 b and silt, so	-bedded gravel, sand,	bogs and ponds locally. Steep terrace escarpment (100 feet) separates dune field from Kuskokwim River flood plain on north and west. This unit lies only on unit (5).  (9a)Gently sloping floodplain of low relief directly in front of existing glaciers in the Susitna drainage; numerous anastomosing, torrential streams.	(9a)Nearly barren gravel flats. (9b)Covered with low willow brush, fireweed, grass, and sedges.	(9a)Excellent. (9b)Very good, except slightly impaired or ponded in old cut off channels. Gravel is very perme-	Absent. U	when Sand when	n frozen or dry. d and gravel high n thawed. When	Easy to excavate when thawed. Difficult to compact if poorly graded, but easy to compact in well-	Excellent for road foundation but alignmen restricted by abundant channels. Numerous bridges or costly spans required to cross these outwash plains. Subject to winter ic to spring and summer floods; and to consta	-(1)	Greenstone, andesite, dacite, basalt, or rhyolite; may also be interbedded with some of the well-consolidated bedded rocks, unit (16).	Beluga Mt. and nearby mountains to the west in the Susitna drainage. Most of these mountains have been covered over (in the mapped area) with glaciers and present rounded, knobby surfaces; relatively steep-sided. Jointing results in prominent grooves in rounded surfaces.	Barren or with carpet of lichens and mosses. Heaths and dwarf birch, with alder and willow thickets near tree-line; few stunted black spruce.	Excellent.		Unsusceptible, Hig local frost sta riving.	able slopes. he quin bles be principle of the principle o	avy equipment for arrying and crush- g. Frost-rived ocks on surface sy to excavate. fficult to compact absence of well-	and foundation good but alignment rather afficult because of steep slopes. Good for riprap, base course, subgrade, or ervious fill. Greenstone and basalt tood for road metal and aggregate if sushed and screened. Andesite, dacite, darhyolite are chemically reactive ocks when used as aggregate and might sintegrate easily.
varying from 25° to 35° Fahrenheit (U.S. Weather Bureau, 1943). Considerable difference is found between the northwest and southeast sides of the mountains, however. The Susitna drainage area is under a maritime influence with a mean annual precipitation of 29.56 inches, which includes 129.7 inches, mean annual snowfall. The Kuskokwim drainage area is under a continental influence with 19.13 inches (87.8 inches snowfall) mean annual precipitation (Fernald, 1960). The McGrath area is characterized by an extreme range of temperatures between summer and winter; the summers are warm and moist and the winters cold and dry. The transition periods are short. There are fewer extremes in the Talkeetna area. The summers are cooler and the winters warmer than at McGrath. Both seasons are rather moist. Arctic or near	10 a 10 b sand and si organic mat sand, and p	-stratified brown and gray ilt with small amounts of terial, overlying well-graded pebble, cobble, and boulder	(9b)Similar to (9a) but with no active streams, although old channels still visible. A few ponded areas or very shallow lakes. Some silt and sand present at the surface.  A broad, gently sloping, undulating plain in Kuskokwim drainage. Borders Alaska Range and glacial moraines; slopes toward the north from 4 to	mountain front, ground is covered with dwarf heath dwarf birch, cottongrass tus-	(10a) Fairly good on upper part of fan be- coming fair to poor on lower part.	from 1 to 5 feet, ground-ice masses present locally	Intense in the fine silt mantle, when negligible in the coarser sediments.	h bearing strength n frozen or dry. d and gravel high n thawed. Silt has	Difficult to exca- vate when frozen. When thawed, vis- cous silty sedi-	channel shifting. Strong winds present nea the glaciers in winter possibly impairing snow removal. Gravel good for subgrade, ba coarse, and if screened, for road metal.  (10a) Fair to good foundations, after stripp ing silty material, near mountains and on upper parts of fam, Little grading required except across terrace escarpments. In lowe			-	f - , -					·	
Glaciation and permafrost  The effect of abundant moisture in the Susitna drainage is seen by the presence of large glaciers on the southeast side of the mountains compared with a few small ones on the Kuskokwim side. A similar relation, although under more rigorous climatic conditions, existed during the ice ages. The whole Susitna valley was once filled by glacial ice which covered some of the lower mountains and hills such as the Peter's Hills, Yenlo Hills, Beluga Mtn., and even Mt. Susitna. Deposits of a major valley glacier in the mapped area have been recorded from as high as 1,396 feet (Péwè and	(10a) Cutwash fan deposits (10b) Cutwash fan deposits with silt up to 2 fee (10b) Same 10 feet of eclian silt and gravel.	at thick. as (10a) above but with 2 to peat and a thick blanket of			developed on both units but most common on (10b).	in silt mantle, particularly in unit (10b). Poly- gonal patterned ground present locally.	streunle sili upor man ject land ed d drai	ength when thawed	dant; fairly good	parts of fan gravel is at depth of as much as 15 feet. Road must be aligned to avoid numerous boggy areas. Large quantities of well-graded gravel and sand available with unit. (10b) Fair to poor for road construction. Numerous swamps and bogs. Subject to seasonal frost action as well as subsidencupon thawing of ground-ice masses. Rell-graded sand and some gravel available at depths up to 25 feet.	n							•		
others, 1953, p. 3). Some of these deposits are very thin or consist of isolated erratic boulders, so, for the purposes of this report, only glacial deposits which average 5 feet or more in thickness are mapped as such. Localities, as tops of the higher hills and low mountains, where the drift is thin, are mapped as bedrock. Ground moraine blankets the Susitna valley but all except the most recent of glacial deposits are covered in turn with a few inches to 2 feet of windblown silt (loess).  Glaciation in the Kuskokwim drainage area was not so extensive as in the Susitna area. Large glaciers occupied the valleys on the north side of the Alaska Range and extended	in size fro		Inactive remmants of most recent glaciation located high in mountains, may grade downward into a rock glacier.	Generally barren except for few lichens and mosses.	Excellent.	ing temperature, moraine may be ice-cored with remnant of	1 0	ep stable slopes.	Could be excavated with power tools but some blasting might be necessary. Easy to compact if sufficient grade size range present.	Good foundation for road construction but very limited serial extent. Possibility is remote that these deposits mild be encounted in the course of normal road constructive because of their location in the mountains unless some very high pass through the Alaska Range is considered. Good source for subgrade and base course if screened.	er-							· · · · · · · · · · · · · · · · · · ·		
some 20 miles out from the mountain front but did not coalesce to form piedmont glaciers. End moraines of the valley glaciers form prominent arcuate ridges with outwash deposits fanning out in front of them.  The wind played a large role in the more arid glacial and post-glacial climate of the north side of the Alaska Range, and abundant eolian deposits of sand and silt are found covering bedrock, old alluvial sediments, and glacial drift.  Permafrost is sporadically present in the Susitna drain-		HANICAL ANALYS SAMPLES A THROUGH	IS HOLE	D SAMPLE NO. LAB SAMPLE NO.  E & STATION DEPTH  SILT : CLAY	FORM 10 - 348 12 - 58 COBBLES	OF S	CHANICAL A SAMPLES E T	ANALYSIS HROUGH I	S DEPARTMENT OF COMMER BUREAU OF PUBLIC ROADS REGION IO	FIELD SAMPLE NO. LAB SAMPLE NO HOLE & STATION DEPTH  SILT CLAY	FORM 10 - 348 12 - 58	MECHANICAL AN OF SAMPLES J THR		FIELD SAMPLE NO. LAB SAMPLE NO.  HOLE & STATION DEPTH  SILT " CLAY	FORM 10 - 348 12 - 58	ME OF GRAV COARSE   MEDIUM	CHANICAL SAMPLES M	ANALYSIS THROUGH O  COARSE GRAIN SIZE	S DEPARTMENT OF COMMERCI BUREAU OF PUBLIC ROADS REGION IO	FIELD SAMPLE NO. LAB SAMPLE NO.  HOLE & STATION DEPTH  SILT CLAY
age area and presents few foundation problems except at high elevations. However, on the Kuskokwim side of the mountains it is widespread and must be considered in the construction of roads over most of the units. Seasonal frost action can be intense in poorly drained, fine-grained sediments on both sides of the mountains.  References cited  Brooks, Alfred H., 1911, The Mount McKinley region, Alaska: U.S. Geol. Survey Prof. Paper 70, 234 p.  Capps, Stephen R., 1913, The Yentna district, Alaska:	[ <del>[ + · · · · · · · · · · · · · · · · · · </del>		-88888888888888888888888888888888888888	00 00 00 00 00 00 00 00 00 00 00 00 00	50			-60 - 9 5		5 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	90			2 2 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	20 BO	8288			-8868 8 8	5 5 588 8 8 8 8 8 8 8 0 0 0 0 0 0 0 0 0
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Survey, Eng. Intel. Div., Office, Chief of Engineers, 52 p.  Pewe, Troy L., and others, 1953, Multiple glaciation in Alaskaa progress report: U.S. Geol. Survey Circ. 289, 13 p.  U.S. Weather Bureau, 1943, Climatic atlas for Alaska: Army Air Forces, Weather Information Branch, Headquarters, Rept. 444 (229 p.) and supplement (72 p.).	SIZE OPENING (IN.)  L. L. SOILS		HYD  BY: CHECKED BY:	GRAIN SIZE (MM)  ROMETER ANALYSIS  DATE:	800 CLL P1	SIZE OPENING (IN.)	SIEVE AN	MESH (U.S. SHL) NALYSIS PLOTTED BY:	CHECKED BY	GRAIN SIZE (MM) - HYDROMETER ANALYSIS	L. L. P. 1.	SIZE OPENING (IN.)  SIEVE ANA  SOILS CLASSIFICATION:	NO MESH (U.S. Std.) - +	GRAIN_SIZE (MM) ——————————————————————————————————	00 0	SIZE OPENING (IN.)	SIEVE  SIEVE  OILS CLASSIFICATION:	NO MESH (U.S. SM.	CHECKED BA:	GRAIN SIZE (MM) ——————————————————————————————————
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